

## APPENDIX E

# Distribution of Furans and Dioxins in Tittabawassee River Sediment

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This appendix describes the analytical data and methods used to characterize the lateral and vertical distributions of furans and dioxins in Tittabawassee River sediment.

## Evaluation Objective

The objective of the sediment evaluation was to characterize the distribution of polychlorinated dibenzo-p-dioxins (dioxin) and polychlorinated dibenzo-p-furans (furan) and in surface and subsurface sediment and to identify possible patterns or trends in their distribution that might allow prediction of furan and dioxin concentrations in portions of the study area that have not been sampled.

## Analytical Data Used in Evaluation

Furan and dioxin data are presented in this appendix as toxic equivalent (TEQ) concentrations. The 1998 World Health Organization (WHO) mammalian toxic equivalency factors (TEF) were applied in deriving estimates of TEQ. The TEFs that were used for this evaluation are provided in Table 2-4 of the Tittabawassee River and Floodplain Remedial Investigation Work Plan (RIWP). The measured concentration of each furan and dioxin congener is multiplied by the corresponding TEF, and the products are summed to determine the TEQ concentration as shown in Equation 1:

$$\text{Total TEQ (2,3,7,8-TCDD equivalents)} = \sum (\text{Congener-specific concentration} * \text{Congener-specific TEF}) \quad (1)$$

The data set used in the TEQ distribution evaluation included all existing sediment samples for which the results for 17 congeners were available and the TEQ could be calculated. The data set consisted of 97 surface sediment (0 to 0.3 feet below sediment surface [bss]) samples and 83 subsurface sediment samples (greater than 0.3 feet bss) for a total of 182 samples. The surface sediment data set included both regularly spaced and clustered sample locations, as shown in Figures 2-20a, 2-20b, and 2-20c of the RIWP. A variety of sampling dates and investigations are represented in the data set. A full listing of the samples and TEQ results used in this evaluation is provided in Table E-1. Analytical data for the surface sediment and subsurface sediment data sets are summarized in Table 2-5 of the RIWP.

## Preliminary Evaluations

The preliminary evaluation of TEQ distribution consisted of graphing TEQ concentrations by distance downriver from The Dow Chemical Company (Dow) Midland Plant in Midland, MI (Midland Plant), as shown in Figure 2-21 of the RIWP, and by depth and

distance down river, as shown in Figure 2-22 of the RIWP. Sample depth and distance information is provided in Table E-1.

The median TEQ concentration in surface sediment over the length of the study area is 32 parts per trillion (ppt); however, concentrations vary over four orders of magnitude, with TEQ concentrations ranging from 0.58 ppt to 9,300 ppt. Figure 2-22 of the RIWP is a plot of sediment TEQ concentrations with increasing distance downstream of the Midland Plant. The scattered distribution of TEQs along the length of the study area indicates a lack of longitudinal trend with distance from the Midland Plant. A high degree of local variability is also apparent, with TEQ varying over four orders of magnitude among very closely spaced samples. Thus, even short reaches of the river appear to be similar to the overall length of the river in terms of the variability of TEQ in surface sediments. As discussed in the Tittabawassee River Sediment Dioxin/Furan Variability Study (CH2M HILL, 2005a), there is no indication of discrete areas with consistently elevated TEQ.

Higher TEQ concentrations tend to be found in surface sediment compared to deeper subsurface sediment, with median values of 32 and 9.5 ppt, respectively (Table 2-5 of the RIWP). However, the highest reported TEQ concentration of 19,000 ppt occurred in a subsurface sample (3-4 feet). Figure 2-22 of the RIWP shows TEQ concentrations in surface and subsurface samples along the length of the river in the study area. No clear pattern or trend in TEQ concentration with depth is apparent, and a high degree of vertical variability is found throughout the length of the study area and within individual cores.

Investigations to date have not identified any locally elevated areas of furans and dioxins or significant areas of fine-grained sediment that might represent depositional areas where hydrophobic chemicals would be expected to accumulate. Dow evaluated sediment variability in a statistically-based sampling program that included samples collected in the summer of 2004 adjacent to, or at the same location as samples with elevated TEQ concentrations (greater than 1,000 ppt) that had been previously measured in the fall of 2003 (CH2M HILL, 2005a). The results for the variability study samples are shown as insets on Figure 2-20a through 2-20c, and are included in the longitudinal variability plot (Figure 2-21). This evaluation found that the elevated TEQ concentrations could not be replicated in the second sample round. TEQ concentrations in adjacent sediment samples varied over three orders of magnitude (which is comparable to the degree of variability over the entire river), while the 2004 sample concentrations were typically an order of magnitude lower in concentration than the concentrations originally measured in 2003.

## Geostatistical Evaluation of TEQ Spatial Variability

The long- and short-scale spatial variability of TEQ concentrations in sediment were further evaluated using geostatistical analysis.

### Methodology

Spatial statistical methods have been well developed for application to environmental data (Goovaerts, 1997) and have been applied in numerous sediment and soil studies (for example, Barabas, et al., 2001). The methods explore the variance of a variable in a

population as a function of separation distance between sample locations. In a given population of spatial samples, the difference between any two concentration measurements can be expected to be smaller for small distances than for large distances if a spatial pattern or trend exists. Calculating and plotting the variance of differences (called semivariance) for sample pairs in different distance classes yields a function called the semivariogram. If spatial correlation on any scale exists, the semivariogram will rise from a low initial value to a constant within a certain distance called the range (see idealized semivariogram in Figure E-1). The range corresponds to the maximum scale on which spatial correlation can be detected. This method is limited by the smallest distance between any two samples, and only correlation scales equal to or larger than the smallest sampling distance can be detected (in the case of the Tittabawassee River, the smallest separation distance was 5 feet). The range can be indicative of the average size of regions of elevated concentrations. If the semivariogram shows regular cycles of a certain frequency, the regular occurrence of elevated values along the sampled area can be concluded. A semivariogram that rises indefinitely indicates the existence of a trend in the data all the way to the boundaries of the sampled area. Because the calculation involves pairs of samples, the number of available data pairs will decrease sharply after a separation distance corresponding to half the length of the study area, and the semivariogram is calculated to a maximum separation distance corresponding to one half the length of the study domain; beyond this distance, the semivariance becomes erratic. The semivariogram is calculated using the following equation:

$$\gamma(\Delta x) = \frac{1}{2N(\Delta x)} \sum_{n=1}^{n=N(\Delta x)} [C(x_n) - C(x_n + \Delta x)]^2 \quad (2)$$

where:

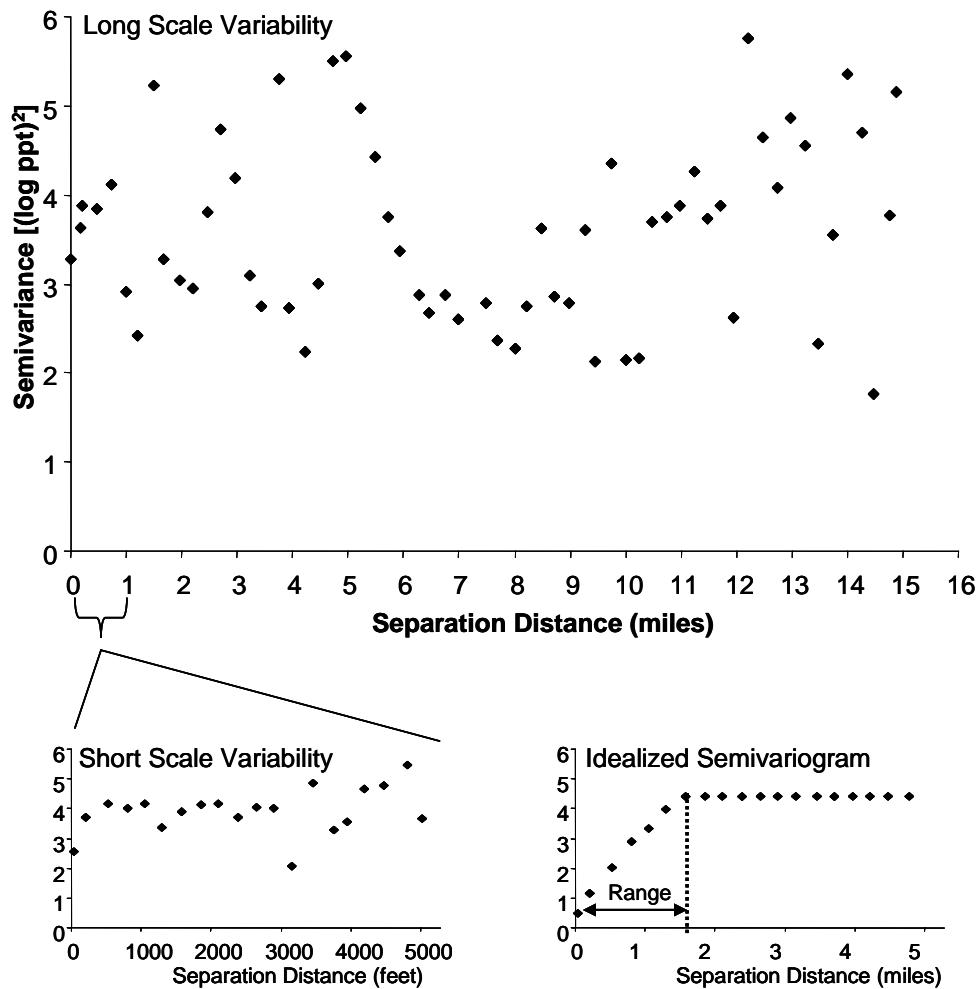
- $\gamma$  is the semivariance
- $x$  is a particular coordinate location
- $\Delta x$  is the separation distance
- $N(\Delta x)$  is the number of data pairs separated by the distance  $\Delta x$
- $n$  is the sample index
- $C$  is the variable of interest, here the concentration of D/Fs.

The calculation is repeated for multiple separation distances. Because the semivariogram is sensitive to extreme values, the calculations were performed on natural log-transformed concentrations {in equation [1] above,  $C(x_n)$  is replaced by  $\ln[C(x_n)]$ }. Log-transformation does not alter the validity of the observed spatial behavior. The coordinate of each sample was represented by its distance from the Dow Midland Plant, in cases where samples shared the same coordinate location, the distance was offset by 0.5 ft. The program *gamv* in the geostatistical software package GSLib was used for these calculations (Deutsch and Journel, 1998).

## Geostatistical Evaluation Results

Figure E-1 shows the semivariogram calculated for the Tittabawassee River sediments, along with an enlarged view of the semivariance behavior for the first mile of the

semivariogram, and an idealized semivariogram exhibiting spatial correlation up to a distance of 1.8 miles for comparison.



**FIGURE E-1**  
**SEMIVARIOGRAM FOR FURAN AND DIOXIN TEQS IN TITTABAWASSEE RIVER SEDIMENT**

The smaller graph on the bottom left shows the semivariance calculated for small separation distances up to the first mile. The smaller graph on the bottom right shows an idealized semivariogram and the general shape that would be expected in the presence of spatial correlation.

The calculated semivariogram exhibits a lack of a trend or any spatial correlation on all scales evaluated, indicating that variability in TEQ concentrations is mostly random. Thus, variability is independent of spatial scale for the river as a whole. The scatter of the graph is also due to the scale-independent high variability. If any small, spatially correlated areas exist, they are patchy, and unstable from one high flow event to the next as evidenced by the lack of reproducibility of high TEQ concentrations in samples collected from the same location at two different times, as discussed above. Given this spatial and temporal variability, it is not feasible to reliably predict or map the distribution of TEQ concentrations at particular locations within the Tittabawassee River.

## References

- Barabás N., P. Goovaerts., and P. Adriaens. 2001. Geostatistical assessment and validation of uncertainty for three-dimensional dioxin data from sediments in an estuarine river. *Environmental Science and Technology*, **35**: 3294-3301.
- CH2M HILL. 2005a. Tittabawassee River Sediment Dioxin/Furan Concentration Variability. March.
- CH2M HILL. 2005b. Tittabawassee River Sediment Dioxin/Furan Concentration Vertical Variability - Revision 1. July.
- Deutsch, C.V. and A.G. Journel. 1998. Geostatistical Software Library and User's Guide. Oxford University Press, New York, 369 pp. (Software available free for download at <http://www.gslib.com/>).
- Goovaerts, P. 1997. Geostatistics for Natural Resources Evaluation. Oxford University Press, New York, 483 pp.

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Table E-1  
Sediment Sample Information

<b>Location ID</b>	<b>Field Sample ID</b>	<b>Sampling Date</b>	<b>Matrix</b>	<b>Sample Depth</b>	<b>TEQ (ppt)<sup>1</sup></b>	<b>Sample Interval</b>	<b>Rivermile</b>
01DEQ-026	01DEQ-026-SED-0033	1-Nov-01	SED	0.00-0.17 FT	5.04	Surface	0.00
DOW-02253	111803-SED-02253-02.10	18-Nov-03	SED	1.1-2.1 FT	20.04	Subsurface	0.00
DOW-02253	111803-SED-02253-00.3	18-Nov-03	SED	0-0.3 FT	3.87	Surface	0.00
04MSU-062	04MSU-062-SED-0001	1-Jan-04	SED	NA	8.05	Surface	0.04
01DEQ-040	01DEQ-040-SED-0049	3-Dec-01	SED	0.00-0.06 FT	2,070.05	Surface	0.09
04MSU-063	04MSU-063-SED-0001	1-Jan-04	SED	NA	12.40	Surface	0.40
01DEQ-039	01DEQ-039-SED-0048	3-Dec-01	SED	0.00-0.06 FT	260.62	Surface	0.67
01DEQ-038	01DEQ-038-SED-0047	3-Dec-01	SED	0.00-0.06 FT	866.90	Surface	0.91
MIC-02252	120903-SED-02252-02.30	9-Dec-03	SED	1.3-2.3 FT	10.17	Subsurface	0.95
MIC-02252	120903-SED-02252-00.3	9-Dec-03	SED	0-0.3 FT	5.64	Surface	0.95
01DEQ-037	01DEQ-037-SED-0046	3-Dec-01	SED	0.00-0.06 FT	21.62	Surface	1.07
MIC-02251	111703-SED-02251-02.50	17-Nov-03	SED	1.5-2.5 FT	1,317.47	Subsurface	1.46
MIC-02251	111703-SED-02251-00.3	17-Nov-03	SED	0-0.3 FT	11.56	Surface	1.46
MIC-02710	063004-SED-02710-00.2	30-Jun-04	SED	0-0.2 FT	43.12	Surface	1.68
MIC-02708	063004-SED-02708-00.2	30-Jun-04	SED	0-0.2 FT	3.79	Surface	1.68
MIC-02709	063004-SED-02709-00.2	30-Jun-04	SED	0-0.2 FT	9.64	Surface	1.68
MIC-02707	063004-SED-02707-00.2	30-Jun-04	SED	0-0.2 FT	4.73	Surface	1.69
MIC-04894	072605-SED-04894-01.00	26-Jul-05	SED	0.5-1.00 FT	0.28	Subsurface	2.88
MIC-04894	072605-SED-04894-00.50	26-Jul-05	SED	0.0-0.50 FT	15.05	Surface	2.88
MIC-04895	072605-SED-04895-02.60	26-Jul-05	SED	2.0-2.60 FT	1,144.92	Subsurface	2.88
MIC-04895	072605-SED-04895-02.00	26-Jul-05	SED	1.5-2.00 FT	24.60	Subsurface	2.88
MIC-04895	072605-SED-04895-01.50	26-Jul-05	SED	1.0-1.50 FT	3.50	Subsurface	2.88
MIC-04895	072605-SED-04895-01.00	26-Jul-05	SED	0.5-1.00 FT	1.40	Subsurface	2.88
MIC-04895	072605-SED-04895-00.50	26-Jul-05	SED	0.0-0.50 FT	5.67	Surface	2.88
FRE-04893	072605-SED-04893-02.70	26-Jul-05	SED	2.0-2.70 FT	0.20	Subsurface	2.88
FRE-04893	072605-SED-04893-02.00	26-Jul-05	SED	1.5-2.00 FT	0.21	Subsurface	2.88
FRE-04893	072605-SED-04893-01.50	26-Jul-05	SED	1.0-1.50 FT	342.96	Subsurface	2.88
FRE-04893	072605-SED-04893-01.00	26-Jul-05	SED	0.5-1.00 FT	39.33	Subsurface	2.88
FRE-04893	072605-SED-04893-00.50	26-Jul-05	SED	0.0-0.50 FT	12.98	Surface	2.88
01DEQ-025	01DEQ-025-SED-0032	19-Oct-01	SED	0.00-0.17 FT	539.76	Surface	3.38
01DEQ-025	01DEQ-025-SED-0030	19-Oct-01	SED	0.33-1.00 FT	354.59	Subsurface	3.38
04MSU-057	04MSU-057-SED-0001	1-Jan-04	SED	NA	84.29	Surface	3.88
04MSU-058	04MSU-058-SED-0001	1-Jan-04	SED	NA	126.47	Surface	3.88
04MSU-064	04MSU-064-SED-0001	1-Jan-04	SED	NA	9.71	Surface	3.88
04MSU-055	04MSU-055-SED-0001	1-Jan-04	SED	NA	31.12	Surface	3.89
04MSU-060	04MSU-060-SED-0001	1-Jan-04	SED	NA	14.46	Surface	3.90
04MSU-061	04MSU-061-SED-0001	1-Jan-04	SED	NA	28.54	Surface	3.90
FRE-02718	063004-SED-02718-00.2	30-Jun-04	SED	0-0.2 FT	12.32	Surface	3.91
04MSU-056	04MSU-056-SED-0001	1-Jan-04	SED	NA	28.35	Surface	3.92
FRE-02717	063004-SED-02717-00.2	30-Jun-04	SED	0-0.2 FT	177.69	Surface	3.92
FRE-02716	063004-SED-02716-00.2	30-Jun-04	SED	0-0.2 FT	9.24	Surface	3.92
FRE-02715	063004-SED-02715-00.2	30-Jun-04	SED	0-0.2 FT	9.27	Surface	3.93
FRE-02250	111403-SED-02250-02.30	14-Nov-03	SED	1.25-2.25 FT	7.97	Subsurface	4.45
FRE-02250	111403-SED-02250-00.3	14-Nov-03	SED	0-0.3 FT	15.51	Surface	4.45
FRE-02249	120903-SED-02249-04.10	9-Dec-03	SED	3.1-4.1 FT	27.75	Subsurface	4.96
FRE-02249	120903-SED-02249-00.3	9-Dec-03	SED	0-0.3 FT	11.37	Surface	4.96
FRE-02726	063004-SED-02726-00.2	30-Jun-04	SED	0-0.2 FT	195.45	Surface	5.57
FRE-02724	063004-SED-02724-00.2	30-Jun-04	SED	0-0.2 FT	366.29	Surface	5.57
FRE-02725	063004-SED-02725-00.2	30-Jun-04	SED	0-0.2 FT	133.63	Surface	5.58
FRE-02723	063004-SED-02723-00.2	30-Jun-04	SED	0-0.2 FT	14.14	Surface	5.59
FRE-02248	120803-SED-02248-00.75	8-Dec-03	SED	0.3-0.75 FT	7.13	Subsurface	5.95
FRE-02248	120803-SED-02248-00.3	8-Dec-03	SED	0-0.3 FT	10.64	Surface	5.95
01DEQ-036	01DEQ-036-SED-0045	3-Dec-01	SED	0.00-0.06 FT	134.52	Surface	5.98
01DEQ-035	01DEQ-035-SED-0044	3-Dec-01	SED	0.00-0.06 FT	253.75	Surface	6.36
01DEQ-034	01DEQ-034-SED-0043	3-Dec-01	SED	0.00-0.06 FT	1,010.04	Surface	6.63
FRE-02247	120803-SED-02247-03.40	8-Dec-03	SED	2.4-3.4 FT	13.12	Subsurface	8.96
FRE-02247	120803-SED-02247-00.3	8-Dec-03	SED	0-0.3 FT	489.26	Surface	8.96
01DEQ-024	01DEQ-024-SED-0029	5-Sep-01	SED	0.00-0.17 FT	166.64	Surface	10.41
01DEQ-024	01DEQ-024-SED-0028	5-Sep-01	SED	0.33-1.00 FT	933.49	Subsurface	10.41
THT-02246	120503-SED-02246-03.00	5-Dec-03	SED	2-3 FT	0.14	Subsurface	10.71
THT-02246	120503-SED-02246-00.3	5-Dec-03	SED	0-0.3 FT	143.93	Surface	10.71
THT-02772	070204-SED-02772-04.00	2-Jul-04	SED	3.0-4.00 FT	0.23	Subsurface	11.36

Table E-1  
Sediment Sample Information

Location ID	Field Sample ID	Sampling Date	Matrix	Sample Depth	TEQ (ppt) <sup>1</sup>	Sample Interval	Rivermile
THT-02772	070204-SED-02772-00.30	2-Jul-04	SED	0-0.30 FT	11.66	Surface	11.36
THT-02773	070204-SED-02773-04.90	2-Jul-04	SED	3.9-4.90 FT	9.87	Subsurface	11.42
THT-02773	070204-SED-02773-00.30	2-Jul-04	SED	0-0.30 FT	803.15	Surface	11.42
THT-02774	070204-SED-02774-02.85	2-Jul-04	SED	1.85-2.85 FT	8.08	Subsurface	11.44
THT-02774	070204-SED-02774-00.30	2-Jul-04	SED	0-0.30 FT	14.72	Surface	11.44
THT-02775	070204-SED-02775-00.3	2-Jul-04	SED	0-0.3 FT	34.48	Surface	11.44
THT-02244	120403-SED-02244-03.80	4-Dec-03	SED	2.8-3.8 FT	189.76	Subsurface	11.44
THT-02244	120403-SED-02244-00.3	4-Dec-03	SED	0-0.3 FT	265.29	Surface	11.44
THT-02245	111203-SED-02245-00.3	12-Nov-03	SED	0-0.3 FT	9,311.74	Surface	11.44
THT-02776	070104-SED-02776-00.3	1-Jul-04	SED	0-0.3 FT	24.30	Surface	11.44
THT-02777	070104-SED-02777-00.3	1-Jul-04	SED	0-0.3 FT	26.07	Surface	11.44
THT-02779	070104-SED-02779-00.3	1-Jul-04	SED	0-0.3 FT	10.22	Surface	11.44
THT-02782	070104-SED-02782-00.3	1-Jul-04	SED	0-0.3 FT	70.75	Surface	11.45
THT-02783	070104-SED-02783-03.40	1-Jul-04	SED	2.4-3.40 FT	12.67	Subsurface	11.45
THT-02783	070104-SED-02783-00.30	1-Jul-04	SED	0-0.30 FT	18.53	Surface	11.45
THT-02784	070104-SED-02784-03.55	1-Jul-04	SED	2.55-3.55 FT	137.08	Subsurface	11.47
THT-02784	070104-SED-02784-00.30	1-Jul-04	SED	0-0.30 FT	13.79	Surface	11.47
THT-04896	072705-SED-04896-03.00	27-Jul-05	SED	2.5-3.00 FT	12.94	Subsurface	11.55
THT-04896	072705-SED-04896-02.50	27-Jul-05	SED	2.0-2.50 FT	47.57	Subsurface	11.55
THT-04896	072705-SED-04896-02.00	27-Jul-05	SED	1.5-2.00 FT	20.52	Subsurface	11.55
THT-04896	072705-SED-04896-01.50	27-Jul-05	SED	1.0-1.50 FT	75.21	Subsurface	11.55
THT-04896	072705-SED-04896-01.00	27-Jul-05	SED	0.5-1.00 FT	25.90	Subsurface	11.55
THT-04896	072705-SED-04896-00.50	27-Jul-05	SED	0.0-0.50 FT	137.12	Surface	11.55
THT-04897	081105-SED-04897-02.00	11-Aug-05	SED	1.5-2.00 FT	0.25	Subsurface	11.55
THT-04897	081105-SED-04897-01.50	11-Aug-05	SED	1.0-1.50 FT	0.24	Subsurface	11.55
THT-04897	081105-SED-04897-01.00	11-Aug-05	SED	0.5-1.00 FT	4.44	Subsurface	11.55
THT-04897	081105-SED-04897-00.50	11-Aug-05	SED	0.0-0.50 FT	41.92	Surface	11.55
THT-04898	072705-SED-04898-03.00	27-Jul-05	SED	2.5-3.00 FT	18.71	Subsurface	11.55
THT-04898	072705-SED-04898-02.50	27-Jul-05	SED	2.0-2.50 FT	62.57	Subsurface	11.55
THT-04898	072705-SED-04898-02.00	27-Jul-05	SED	1.5-2.00 FT	144.00	Subsurface	11.55
THT-04898	072705-SED-04898-01.50	27-Jul-05	SED	1.0-1.50 FT	43.31	Subsurface	11.55
THT-04898	072705-SED-04898-01.00	27-Jul-05	SED	0.5-1.00 FT	366.46	Subsurface	11.55
THT-04898	072705-SED-04898-00.50	27-Jul-05	SED	0.0-0.50 FT	14.99	Surface	11.55
THT-02785	070104-SED-02785-01.80	1-Jul-04	SED	0.8-1.80 FT	99.47	Subsurface	11.55
THT-02785	070104-SED-02785-00.30	1-Jul-04	SED	0-0.30 FT	1,103.27	Surface	11.55
THT-02786	070104-SED-02786-01.50	1-Jul-04	SED	0.5-1.50 FT	0.47	Subsurface	11.65
THT-02786	070104-SED-02786-00.30	1-Jul-04	SED	0-0.30 FT	6.28	Surface	11.65
THT-02243	120403-SED-02243-03.00	4-Dec-03	SED	2-3 FT	2.11	Subsurface	11.70
THT-02243	120403-SED-02243-00.3	4-Dec-03	SED	0-0.3 FT	8.99	Surface	11.70
01DEQ-023	01DEQ-023-SED-0027	5-Sep-01	SED	0.00-0.17 FT	88.90	Surface	11.79
01DEQ-023	01DEQ-023-SED-0026	5-Sep-01	SED	0.33-1.00 FT	2,034.74	Subsurface	11.79
04MSU-054	04MSU-054-SED-0001	1-Jan-04	SED	NA	367.81	Surface	11.92
THT-02734	062904-SED-02734-00.2	29-Jun-04	SED	0-0.2 FT	4.85	Surface	11.94
THT-02732	062904-SED-02732-00.2	29-Jun-04	SED	0-0.2 FT	8.06	Surface	11.95
THT-02733	062904-SED-02733-00.2	29-Jun-04	SED	0-0.2 FT	44.79	Surface	11.95
04MSU-053	04MSU-053-SED-0001	1-Jan-04	SED	NA	26.85	Surface	11.95
THT-02731	062904-SED-02731-00.2	29-Jun-04	SED	0-0.2 FT	3.95	Surface	11.96
THT-02242	120303-SED-02242-03.90	3-Dec-03	SED	2.9-3.9 FT	0.16	Subsurface	12.96
THT-02242	120303-SED-02242-00.3	3-Dec-03	SED	0-0.3 FT	44.36	Surface	12.96
THT-02241	120303-SED-02241-02.30	3-Dec-03	SED	1.3-2.3 FT	22.28	Subsurface	13.96
THT-02241	120303-SED-02241-00.3	3-Dec-03	SED	0-0.3 FT	117.34	Surface	13.96
01DEQ-033	01DEQ-033-SED-0042	3-Dec-01	SED	0.00-0.06 FT	366.89	Surface	14.11
SHL-02240	120203-SED-02240-01.80	2-Dec-03	SED	0.8-1.8 FT	0.98	Subsurface	14.46
SHL-02240	120203-SED-02240-00.3	2-Dec-03	SED	0-0.3 FT	6.34	Surface	14.46
SHL-02239	120203-SED-02239-04.00	2-Dec-03	SED	3-4 FT	0.31	Subsurface	14.94
SHL-02239	120203-SED-02239-00.3	2-Dec-03	SED	0-0.3 FT	488.56	Surface	14.94
01DEQ-022	01DEQ-022-SED-0025	5-Sep-01	SED	0.00-0.17 FT	59.45	Surface	15.42
01DEQ-022	01DEQ-022-SED-0024	4-Sep-01	SED	0.33-1.00 FT	12.91	Subsurface	15.42
SHL-02238	110703-SED-02238-01.60	7-Nov-03	SED	0.58-1.58 FT	30.74	Subsurface	15.44
SHL-02238	110703-SED-02238-00.3	7-Nov-03	SED	0-0.3 FT	37.30	Surface	15.44
SHL-02237	120103-SED-02237-03.00	1-Dec-03	SED	2-3 FT	0.14	Subsurface	15.95
SHL-02237	120103-SED-02237-00.3	1-Dec-03	SED	0-0.3 FT	24.46	Surface	15.95

Table E-1  
Sediment Sample Information

Location ID	Field Sample ID	Sampling Date	Matrix	Sample Depth	TEQ (ppt) <sup>1</sup>	Sample Interval	Rivermile
01DEQ-032	01DEQ-032-SED-0041	3-Dec-01	SED	0.00-0.06 FT	1,526.08	Surface	16.37
SHL-02236	110703-SED-02236-02.00	7-Nov-03	SED	1-2 FT	23.19	Subsurface	16.45
SHL-02236	110703-SED-02236-00.3	7-Nov-03	SED	0-0.3 FT	16.20	Surface	16.45
01DEQ-031	01DEQ-031-SED-0040	3-Dec-01	SED	0.00-0.06 FT	880.53	Surface	16.66
01DEQ-030	01DEQ-030-SED-0039	3-Dec-01	SED	0.00-0.06 FT	888.70	Surface	16.89
SHL-02788	070904-SED-02788-02.40	9-Jul-04	SED	1.4-2.4 FT	3.33	Subsurface	17.04
SHL-02788	070904-SED-02788-00.30	9-Jul-04	SED	0-0.30 FT	4,517.37	Surface	17.04
01DEQ-029	01DEQ-029-SED-0038	3-Dec-01	SED	0.00-0.06 FT	1,127.49	Surface	17.09
SHL-02789	070904-SED-02789-02.00	9-Jul-04	SED	1.0-2.00 FT	86.68	Subsurface	17.12
SHL-02789	070904-SED-02789-00.30	9-Jul-04	SED	0-0.30 FT	43.40	Surface	17.12
01DEQ-021	01DEQ-021-SED-0023	31-Aug-01	SED	0.00-0.17 FT	146.65	Surface	17.17
01DEQ-021	01DEQ-021-SED-0022	31-Aug-01	SED	0.33-1.00 FT	49.85	Subsurface	17.17
SHL-02790	070904-SED-02790-05.00	9-Jul-04	SED	4.0-5.00 FT	8.06	Subsurface	17.18
SHL-02790	070904-SED-02790-00.30	9-Jul-04	SED	0-0.30 FT	4.47	Surface	17.18
SHL-02792	070804-SED-02792-00.3	8-Jul-04	SED	0-0.3 FT	109.19	Surface	17.21
SHL-02235	112603-SED-02235-02.40	26-Nov-03	SED	1.42-2.42 FT	124.63	Subsurface	17.21
SHL-02235	112603-SED-02235-00.3	26-Nov-03	SED	0-0.3 FT	2,864.34	Surface	17.21
SHL-02793	070704-SED-02793-00.3	7-Jul-04	SED	0-0.3 FT	15.16	Surface	17.21
SHL-02794	070704-SED-02794-00.3	7-Jul-04	SED	0-0.3 FT	516.88	Surface	17.21
SHL-02804	070704-SED-02804-00.3	7-Jul-04	SED	0-0.3 FT	21.31	Surface	17.21
SHL-02795	070704-SED-02795-00.3	7-Jul-04	SED	0-0.3 FT	484.96	Surface	17.22
SHL-02797	070704-SED-02797-03.60	7-Jul-04	SED	2.60-3.60 FT	0.89	Subsurface	17.25
SHL-02797	070704-SED-02797-00.30	7-Jul-04	SED	0-0.30 FT	894.73	Surface	17.25
SHL-02802	070704-SED-02802-02.75	7-Jul-04	SED	1.75-2.75 FT	0.99	Subsurface	17.32
SHL-02802	070704-SED-02802-00.30	7-Jul-04	SED	0-0.30 FT	8.92	Surface	17.32
SHL-02818	070904-SED-02818-00.3	9-Jul-04	SED	0-0.3 FT	607.26	Surface	17.37
SHL-02817	070904-SED-02817-03.00	9-Jul-04	SED	2.0-3.00 FT	9.22	Subsurface	17.38
SHL-02817	070904-SED-02817-00.60	9-Jul-04	SED	0.30-0.60 FT	55.09	Subsurface	17.38
SHL-02817	070904-SED-02817-00.3	9-Jul-04	SED	0-0.3 FT	32.38	Surface	17.38
SHL-02816	070904-SED-02816-00.3	9-Jul-04	SED	0-0.3 FT	39.67	Surface	17.39
SHL-02801	070704-SED-02801-03.25	7-Jul-04	SED	2.25-3.25 FT	0.40	Subsurface	17.42
SHL-02801	070704-SED-02801-00.30	7-Jul-04	SED	0-0.30 FT	7.56	Surface	17.42
SHL-02234	112603-SED-02234-00.3	26-Nov-03	SED	0-0.3 FT	6.38	Surface	17.45
SHL-02234	110603-SED-02234-01.50	6-Nov-03	SED	0.5-1.5 FT	11.54	Subsurface	17.45
SHL-02233	112503-SED-02233-03.90	25-Nov-03	SED	2.9-3.9 FT	19,398.00	Subsurface	18.20
SHL-02233	112503-SED-02233-00.3	25-Nov-03	SED	0-0.3 FT	17.85	Surface	18.20
SHI-04899	072705-SED-04899-02.90	27-Jul-05	SED	2.5-2.90 FT	3.10	Subsurface	18.79
SHI-04899	072705-SED-04899-02.50	27-Jul-05	SED	2.0-2.50 FT	0.31	Subsurface	18.79
SHI-04899	072705-SED-04899-02.00	27-Jul-05	SED	1.5-2.00 FT	0.29	Subsurface	18.79
SHI-04899	072705-SED-04899-01.50	27-Jul-05	SED	1.0-1.50 FT	0.33	Subsurface	18.79
SHI-04899	072705-SED-04899-01.00	27-Jul-05	SED	0.5-1.00 FT	3.88	Subsurface	18.79
SHI-04899	072705-SED-04899-00.50	27-Jul-05	SED	0.0-0.50 FT	4.55	Surface	18.79
SHI-04900	072705-SED-04900-03.00	27-Jul-05	SED	2.5-3.00 FT	0.34	Subsurface	18.79
SHI-04900	072705-SED-04900-02.50	27-Jul-05	SED	2.0-2.50 FT	0.28	Subsurface	18.79
SHI-04900	072705-SED-04900-02.00	27-Jul-05	SED	1.5-2.00 FT	0.51	Subsurface	18.79
SHI-04900	072705-SED-04900-01.50	27-Jul-05	SED	1.0-1.50 FT	2.33	Subsurface	18.79
SHI-04900	072705-SED-04900-01.00	27-Jul-05	SED	0.5-1.00 FT	100.54	Subsurface	18.79
SHI-04900	072705-SED-04900-00.50	27-Jul-05	SED	0.0-0.50 FT	32.91	Surface	18.79
SHI-04901	072705-SED-04901-02.45	27-Jul-05	SED	2.0-2.45 FT	0.44	Subsurface	18.79
SHI-04901	072705-SED-04901-02.00	27-Jul-05	SED	1.5-2.00 FT	0.31	Subsurface	18.79
SHI-04901	072705-SED-04901-01.50	27-Jul-05	SED	1.0-1.50 FT	0.57	Subsurface	18.79
SHI-04901	072705-SED-04901-01.00	27-Jul-05	SED	0.5-1.00 FT	0.32	Subsurface	18.79
SHI-04901	072705-SED-04901-00.50	27-Jul-05	SED	0.0-0.50 FT	0.58	Surface	18.79
SHI-02232	112403-SED-02232-03.70	24-Nov-03	SED	2.67-3.67 FT	0.31	Subsurface	19.71
SHI-02232	112403-SED-02232-00.3	24-Nov-03	SED	0-0.3 FT	59.73	Surface	19.71
01DEQ-020	01DEQ-020-SED-0021	30-Aug-01	SED	0.00-0.17 FT	32.57	Surface	20.41
01DEQ-020	01DEQ-020-SED-0020	30-Aug-01	SED	0.33-1.00 FT	15.24	Subsurface	20.41

<sup>1</sup> Extracted from Locus 10/31/2005

TEQ concentrations reported here are the raw calculated TEQ values, they have not been rounded to two significant figures because the raw calculated values were used in the evaluations presented in this appendix.